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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Serra, Luis

Serial No. : 10/725,772

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For : SYSTEM AND METHOD FOR DISPLAYING AND COMPARING 3D MODELS

Examiner : Vo, Cliff N.

Group Art Unit : 2676

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Commissioner for Patents
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CERTIFICATE OF MAILING UNDER 37 CFR 1.8

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Date: MAY 30, 2006

Signature:

Aaron S. Haleva, Reg. No. 44,733

DECLARATION OF DR. LUIS SERRA UNDER 37 C.F.R. 1.131

1. I am Luis Serra, Ph.D., the inventor of the above-identified patent application.

2. I make this declaration to establish the date of my invention as being prior to May 18, 2001, the filing date of U.S. Patent No. 6,826,297 to Saito et al ("Saito"), which has been cited against the above-identified application as prior art.

3. Attached hereto as Exhibit A is a true and correct copy of an original Disclosure of Invention ("the Disclosure of Invention") for the invention described in the above-identified application. I prepared this for submission to our original patent attorneys. The Disclosure of Invention was written by me (and an assistant who is not an inventor) on March 8, 2001, and comprises a title page and three pages of disclosure. The Disclosure of Invention was written in Singapore, my country of residence, a WTO member country.

4. Attached hereto as Exhibit B is a true and correct screen capture of a display on my computer, which shows the results of my having clicked on the "Properties" button associated with this document, overlayed on a background of the first page of the document itself which I had open on my computer screen at the time I captured the screen. Exhibit B shows that the document of Exhibit A was created on March 8, 2001 and modified later that same day.

5. The Disclosure of Invention clearly describes volumetric data sets being compared in 3D and rendered fused, that is, displayed simultaneously on the same virtual space. Since the volumes are fused they can be compared against each other by a combination of rendering techniques.

6. The Disclosure of Invention further describes displaying two 3D data sets together, such as different modalities of the same object, using a variety of possible views for each modality. These include, for example, using the cutting planes of one volume to reveal the other, such as is shown for example in Figs. 11-28 of the above-identified patent application, displaying a cutting plane from each volume, displaying one semi-transparently, or using mixed visualization modes for each object.

7. The Disclosure of Invention further describes several display modes for the invention, including: roaming mode, cropping mode, same planes locked together, one slightly above the other and slightly transparent, and a checkerboard comparison mode (such as is shown in Figs. 3a and 3b of the above-identified patent application).

8. Given the date on which I wrote the Disclosure of Invention, which clearly describes the invention which is the subject of the above-identified patent application, I respectfully request that the Saito reference be removed as a prior art reference against the above-identified patent application under 37 C.F.R. 1.131.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the above-identified application or any patent issued thereon.

Dated: May 30, 2006

Luis Serra, Ph.D.

Disclosure of Invention

Title: Method to verify the accuracy of the registration and segmentation of 3D volumetric images using visual inspection and 3D manipulations.

Authors: Luis Serra, Ng Hern

3/8/01

Title: Method to verify the accuracy of the registration and segmentation of 3D volumetric images using visual inspection and 3D manipulations.

Abstract

Method to verify the accuracy of the registration and segmentation of 3D volumetric images using visual inspection and 3D manipulations.

Background of the Invention

Field of Invention

This invention relates to the field of computer graphics and human-computer user interface systems. More particularly, this invention relates to a 3D interactive tool to verify visually the accuracy of volumetric operations like registration of multimodal 3D volumes and the segmentation of sub-volumes.

2. Art Background

Describe the problem: Comparing 3D objects.

Operations on volumetric data usually involve "verifying" or "comparing" two or more volumes, to measure for example how accurate a registration between two volumes is.

Another important operation in volumes is "segmentation", which relates to the process of subdividing a volume into smaller segments like a tumor from a brain, be it for the purpose of quantifying its properties, or to study its shape or fit within the larger volume. Whatever the method used to obtain a segment out of a volume, there is the need to determine how accurate a segmentation is with respect to the original volume, and this requires in the end human intervention.

Why needed?

Art approach is to break the problem down to comparing in 2D, one cut of the object (a slice) against another, or a cross section of a 3D polygonal mesh against another cross section, or a volume slice. This gives only a partial view of the entire problem, and requires tedious, plane by plane comparison.

We propose to compare volumes directly in 3D space, using a combination of visualization techniques and 3D interaction techniques as described in this patent.

Background

Volumetric data is obtained from digitizing or scanning objects in the real world, like for example a Computer Tomography (CT) scan of a person's head. The scans result in a stack of slices. The slices can be displayed as 3D reconstructions by means of a process called volume rendering. For complex objects (e.g., a human head) it is becoming increasingly common to require more than one scan modality since modality can only reveal a partial aspect of the whole. For example, a CT scan is good to reveal the bone structure but inadequate to show well the soft tissue (for example, a

tumor). To view the entire object, it is then important to first, register together the different modalities of the same object, and second display them together (fuse). Registration requires accurate relative positioning of the two volumes. Fusion requires visual correctness of the resulting image.

Definitions

Visualization modes:

Triplanar

Full

Cutbox

Monoplanar

Summary of the Invention

A method is disclosed that allows a user to compare two 3D volumetric objects against each other.

The method uses the 3D interaction environment of the Dextroscope [define].

The method is useful to determine the accuracy of segmentation and registration between to volumetric data sets.

In this method, volumetric data sets are compared in 3D, with a stereoscopic display, and rendered "fused", that is, displayed simultaneously on the same virtual space. Since the volumes are fused, the can be compared against each other by a combination of rendering techniques under the control of 3D interaction tools. The volumes reside in the same virtual space.

Messy from here onwards...

The user controls the cutting planes of one volume to reveal the other, or move two cutting planes simultaneously (one for each volume). The cutting planes reveal a cross-section of one volume that can then be compared against another cross-section of another volume.

If the object closer to the user's viewpoint is opaque, it obscures the object underneath, and the comparison cannot be achieved. In this case, the validation tool uses different approaches:

- transparency control of the object. Either object (but usually the object closer to the viewpoint) can be turned semi-transparent under user control so that the two objects can be seen simultaneously and thus compared.
- Mixed visualization modes for each object. Either object can be visualized in a mode that allows seeing partially through the object. For example, one object can be displayed in triplanar mode while the other is displayed in full mode. This case applies when one is comparing for example a head CT to MR registration, and the user wants to see how good the fit of the skull bone is. The CT can be displayed full, and the MR in triplanar. The CT only displays the bone (not the surrounding tissue) and the MR covers the whole head, so that the outer layers of both sets are visible. Or one object can be in cutbox mode while the other is in full mode or triplanar mode.

The validation tools also works in "volume to polygon" mode, to verify the accuracy of segmentations (contours extracted from volumetric images).

The validation tool also work in "volume to real object" mode, to verify the matching of computer-generated images against real objects seen through a half-silvered mirror or a video camera feed.

Independent of the visualization mode of each data, the method has several modes of operation

- Roaming mode. The two objects are cropped along the same planes
- Cropping mode. Each object is cropped along different planes.
- Same planes locked together.
- One slightly above the other & slightly transparent (the one above)
- Checkerboard comparison mode. The two objects are displayed alternatively to allow a general view of the fit.

Extensions:

- More than two objects
- Time variant comparisons. Dynamic against static objects.

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Disclosure of Invention

Title: Method to verify the accuracy of the registration and segmentation of 3D volumetric images using visual inspection and 3D manipulations.

Authors: Luis Serra, Ng Hern

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